UIT Observations of the SMC

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Abstract.
A mosaic of four UIT far-UV (FUV; 1620Å) images, which covers most of the SMC bar, is presented, with derived stellar and HII region photometry. The UV morphology of the SMC's Bar shows that recent star formation there has left striking features including: a) four concentrations of UV-bright stars spread from northeast to southwest at nearly equal (∼30 arcmin=0.5 kpc) spacings; b) one concentration comprising a well-defined 8-arcmin diameter ring surrounded by a larger Hα ring, suggestive of sequential star formation.

FUV PSF photometry is obtained for 11,306 stars, and FUV photometry is obtained for 42 Hα-selected HII regions, both for the stars and for the total emission contained in the apertures defined by KH [1]. The flux-weighted average ratio of total to stellar FUV flux is 2.15; the stellar FUV luminosity function indicates that most of the excess total flux is due to scattered FUV radiation, rather than faint stars. Both stellar and total emission are well correlated with Hα fluxes measured by KH, and yield FUV/Hα flux ratios that are consistent with models of single-burst clusters with SMC metallicity, ages from 1-5 Myr, and moderate (E(B-V)=0.0-0.1 mag) internal SMC extinction.

UV observations from above the earth's atmosphere are vital for understanding Population I properties of metal-poor, "primitive"galaxies such as the Small Magellanic Cloud (SMC) [2]. Many effects of composition differences appear best, or only, in the UV. Line blanketing strongly affects UV colors; the steep SMC extinction curve ($A_{162}/E(B-V) \sim 16$), widely thought to be due to abundances in SMC dust, is "extreme" only in the UV; and FUV photometry is more effective than optical-band photometry in determining temperatures of hot stars. Here, we present initial results based on a mosaic of four, 40-arcmin diameter, 3-arcsec-resolution, far-UV images, nearly covering the SMC bar, (figure 1) obtained by the Ultraviolet Imaging Telescope (UIT) during the Astro missions. Details of UIT hardware, calibration, operations, and data reduction are in [3], and detailed results of the current study are in [4].

Figure 1 shows that the SMC's FUV emission originates mostly in hot stellar populations which, while not restricted to clusters, are significantly clumped. No diffuse FUV emission is readily apparent. The brightest features are NGC 346 and

NGC 330, in Fields 4 and 3, with additional FUV concentrations centered in fields 1 and 2. The bright FUV concentrations, spaced along the Bar at ∼0.5kpc intervals, have similar clustering and distribution properties to those evident in wide-field FUV images of the LMC [5].

UIT field 2, near the Bar's center, provides an intriguing instance of what appears to be sequential star formation. A ring of FUV-bright stars dominates the field, and other evidence, including HI shells [6] surrounding the stellar ring, an old supernova remnant 0050-728 [7] at its northern edge, and broad Hα linewidths [8] at the ring's center, shows ties between the distribution of hot stars and the gas dynamics.

We have derived far-UV PSF photometry for 11,306 stars and correlated our observations with ground-based stellar photometry. Figure 2 is the (m(162)−V),V color-magnitude diagram for 191 stars from [9]. Discrete symbols are observed stars, uncorrected for reddening, with spectral types. Solid lines and evolutionary tracks show paths of 10, 15, 20, and 40 $M_\odot$ SMC-composition models ([10], [11]) corrected for distance and foreground Galactic extinction. The reddening vector shows a typical large value for the SMC. The tracks show that these stars predominantly have masses 10–20$M_\odot$ and imply ages 10–30 Myr. The general segregation of

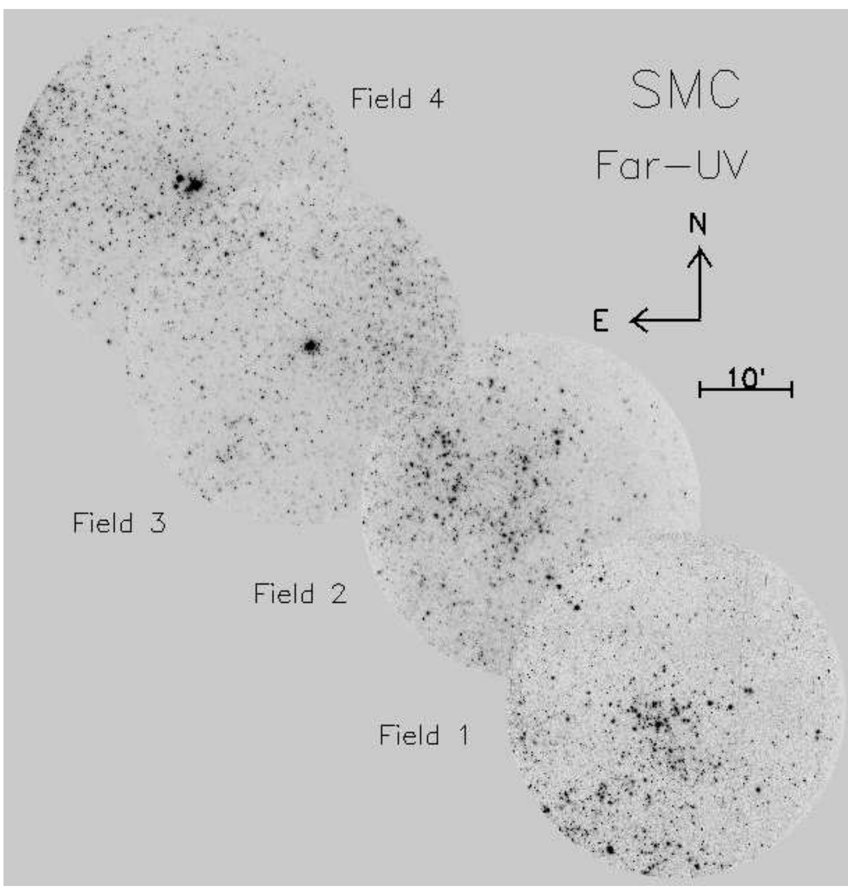

FIGURE 1. FUV Mosaic of the SMC Bar

spectral types by color implies that much of the (m(162)−V) color variation seen in this figure is due to the intrinsic colors of the stars themselves.

We have measured FUV fluxes for 42 HII regions measured at Hα by KH [1], and compared the observed FUV/Hα flux ratios with cluster models. Figure 3 shows these data. Open diamonds are aperture fluxes, and crosses are the sum of stellar fluxes in the apertures, uncorrected for Galactic foreground reddening. The FUV flux is well correlated with Hα and the ratio of FUV aperture to stellar flux is relatively uniform. The ratio measures the relative amounts of "diffuse"

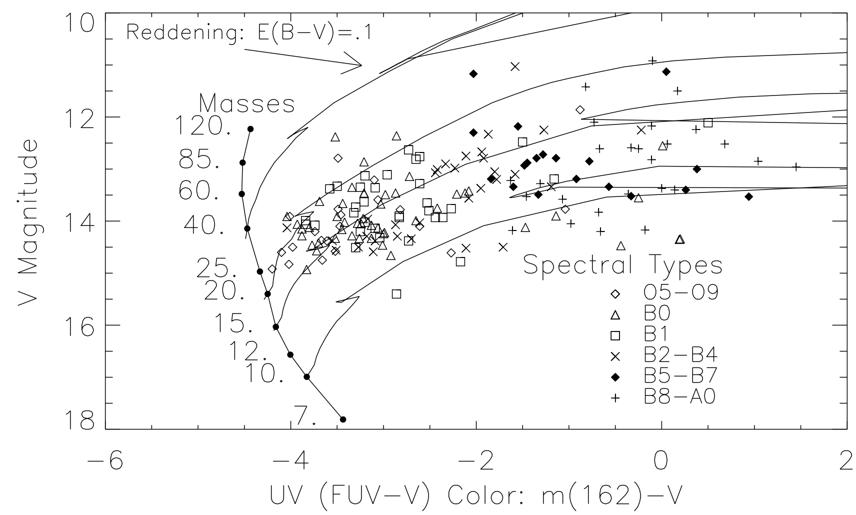

FIGURE 2. SMC (FUV-V,V) Color-Magnitude Diagram

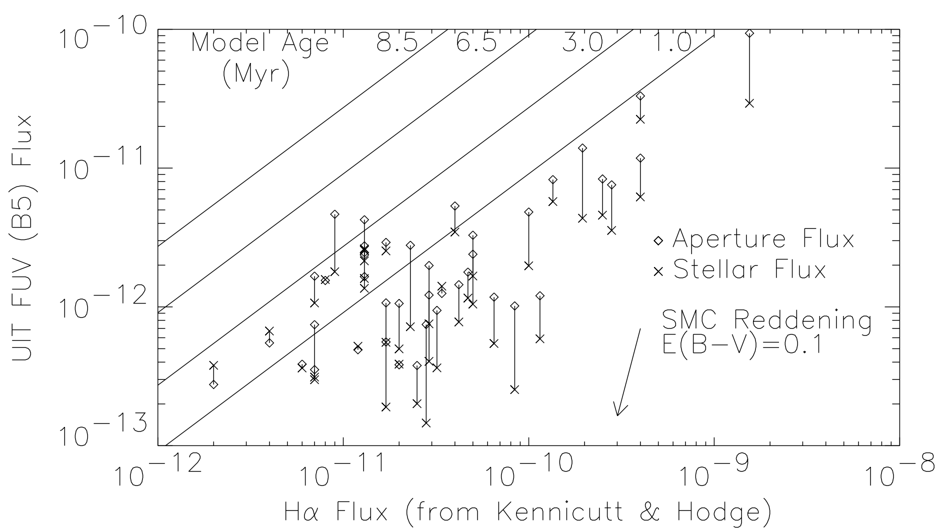

FIGURE 3. (FUV vs. Hα Flux for HII Regions

light (which includes faint stars and scattered light) and light from bright stars. The flux-weighted average ratio of aperture to stellar flux is 2.15. Two arguments point to a dust-scattering origin for most of the excess FUV aperture flux, however. First, the total-to-stellar FUV flux ratio for the Orion nebula, with few undetected stars, is 2.5 [12]. Second, extrapolating the FUV luminosity function predicts an additional stellar flux contribution of only 22%. In spite of low dust abundance, scattering of FUV radiation is important in the SMC.

The FUV/Hα ratio is known to be a good diagnostic of HII region evolution [13]. We have modelled [14] F(162)/Hα ratio values for SMC-composition clusters with single-burst star formation. The ratio rises monotonically from 0.1 at 1 Myr to 4.3 at 10 Myr; foreground- corrected ratios for various cluster ages are plotted as solid lines in Figure 3. The observed HII regions are evidently no older than $\sim$5 Myr for any internal SMC reddening, and are likely between 1 Myr and 3 Myr in age. This result is consistent with observations of HII regions in galaxies as disparate as NGC 4449 [13] and M81 [15].

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